No. 92101 ANTENNA MATCHING PREAMPLIFIER

1. General

The Millen 92101 Antenna Matching Preamplifier is a commercial version of the R9'er. It is the result of the combined engineering efforts of the General Electric Company and the James Millen Manufacturing Company, Inc. The 92101 preamplifier is an electronic impedence-matching device and a broad-band preamplifier, designed to work on the 10 and 6 meter amateur bands. Since some receivers do not match the antenna impedance too well at 20 meters, twenty meter coils are also available. Band-pass coils are available for the 6, 10 and 20 meter amateur bands. The 10 meter coils may be used on the 11 meter band. The amplifier is supplied with one set of plug-in band-pass coils, the No. 46910, covering the range of 27 to 32 mc. Additional coils may be purchased from Millen distributors:

No. 46920 for 13 to 15 mc.
No. 46906 for 48 to 55 mc.

2. Description

The shielded band-pass coils are plugged in through the front panel. A switch, for connecting the Antenna Matching Preamplifier in and out of the receiver antenna input circuit is on the front panel of the preamplifier. The PEAKING control on the panel of the preamplifier is for adjusting the screen voltage on the 6AK5 amplifier tube for maximum gain for the particular plate voltage used.

INPUT TUNING and OUTPUT TUNING controls are on the front panel. These are adjusted only when changing bands. A four-connection jack and plug for power input are on the rear panel.

RF INPUT and OUTPUT jacks and plugs are on the rear panel.

3. Installation

Remove the preamplifier from the housing by removing the four screws at the corners of the front panel. Insert a 6AK5 tube in the miniature tube socket and replace the tube shield. Use care in inserting the tube in the socket. Do not force, as this may bend the tube pins. Replace the unit in the housing.

The Antenna Matching Preamplifier is designed to operate from the receiver power supply. The plate voltage is not critical; any voltage from 150 volts to 275 volts may be used. The total current drain is 10 to 15 milliamperes. A power input plug is supplied to facilitate connecting the amplifier to the receiver power supply. Neither side of the 6AK5 heater is grounded directly so that the 6.3 volt heater voltage from the receiver may be connected to the 6 volt terminals on the amplifier, even though the receiver heater supply may be grounded at the center tap of the transformer. If it is known that one side of the 6.3 volt supply is grounded in the receiver, ground pin 4 on the amplifier power input plug.

Use the co-axial cable connectors supplied to connect the amplifier to the receiver antenna input and to connect the antenna to the 92101. Wire leads, rather than co-axial cable may be used if necessary, but they should be well insulated. Make the leads from the 92101 output to the receiver as short as practical.

4. Tuning

Plug the desired coil assembly in the front of the amplifier. Remove the two screws from the panel of the coil assembly. This will allow the coil panel to be removed so that the coils may be adjusted. The coil on the left is the grid coil; the coil on the right is the plate coil. Do not attempt to remove the coil assembly from the amplifier while the panel is off

the coil assembly, as the coil assembly might get turned around so that the grid coils are reversed.

Switch the preamplifier OUT and tune the receiver to a signal near the center of the band. A local signal is easier to use than a fading signal. Switch the preamplifier IN and turn the PEAKING control full clockwise.

Watching the S-meter on the receiver, tune the grid coil, L1, and the INPUT TUNING condenser, C2, for maximum receiver signal. The coils should be adjusted by an insulated screw driver, preferably all insulating material with no metal tip. The suggested procedure is to set L1 and tune the INPUT TUNING condenser for maximum receiver output, change L1 slightly and retune the INPUT TUNING condenser. Repeat this process until the maximum signal is obtained. The antenna impedance is now matched to the preamplifier grid. If the INPUT TUNING capacity is at full maximum or minimum capacity, 0 or 10 on the dial, the length of the antenna feeder should be changed. Add approximately a quarter-wave length of line; 16 feet on 20 meters, 8 feet on 10 meters and 5 feet on 6 meters. Prune the length of line until the INPUT TUNING control tunes near the center of the dial.

The output side of the amplifier is tuned in the same manner as the input side. Tune the plate coil, L2, and the OUTPUT TUNING condenser, C7, for maximum receiver signal. Set L2 and tune the OUTPUT TUNING condenser, change L2 slightly and retune the OUTPUT TUNING condenser. Repeat this process until the maximum signal is obtained. The preamplifier output impedance is now matched to the receiver input impedance; and through the Antenna Matching Preamplifier, the antenna impedance is matched to the receiver input impedance. If the OUTPUT TUNING capacity is at full maximum or minimum capacity, 0 or 10 on the dial, the length of the line between the preamplifier OUTPUT and the receiver antenna input must be altered. Add approximately a quarter-wave length of line and prune until the OUTPUT TUNING control tunes near the center of the dial. The output line should be as short as possible for 6-meter operation.

Replace the panel on the coil assembly and readjust INPUT TUNING and OUTPUT TUNING for maximum signal. Adjust the PEAKING control for maximum signal. Keep the PEAKING control as far counter-clockwise as is consistant with high gain.

Once all adjustments are made for both coils, it is only necessary to tune INPUT TUNING and OUTPUT TUNING when changing bands. The INPUT TUNING AND OUTPUT TUNING condensers need be adjusted **only** when changing bands.

5. Coils

The Antenna Matching Preamplifier is supplied with one band-pass coil assembly. Available coil assemblies are listed below.

Catalog Number	Band Meters	Tuning Range Megacycles	Band Pass Megacycles
46906	6	48-55 mc.	4 mc.
46910	10-11	27-32 mc.	2 mc.
46920	20	13-15 mc.	1 mc.

The 46910 coil assembly will tune either the 10 or 11 meter amateur bands but the band-pass is not sufficiently great to cover both bands completely. Those operators who use both the 10 and 11 meter bands may find it convenient to have two 46910 coils assemblies, one tuned for each band.

Since the input impedance of most receivers at 40 meters and 80 meters is approximately the antenna impedance, the Antenna Matching Preamplifier is generally not required for those bands. If, however, it is desired to operate the 92101 on 40 meters or 80 meters, coil assemblies can be made from standard catalog parts. The coil forms are Millen No. 69041 and the pins on the coils are Millen No. 10029.

6. Terminal Summary

Power Requirements:

6.3 volts at 175 milliamperes—A.C. or D.C.
150 to 275 volts dc. at 10 to 15 milliamperes.

Physical Dimensions:

Height—5¾ inches
Width—6⅜ inches
Depth—4¼ inches overall (including knobs)
Weight—2⅜ pounds

Tube Required:

1—6AK5 (General Electric)

7. Performance

The gain which can be realized by the use of the Antenna Matching Preamplifier depends on how well the antenna is matched to the receiver input impedance. The gain in the preamplifier itself is approximately 30 db and an additional gain of from 15 to 30 db is usually realized because of matching the impedance of the antenna feeder to the receiver input. Since the input impedance of most commercial receivers is considerably higher on ten meters than the rated input impedance, most receivers are poorly matched to the antenna feeder. The Antenna Match Preamplifier corrects this general difficulty.

Signal strengths will be increased from 30 to 60 db by the use of the 92101. This means that many signals will be heard which, without the 92101, cannot be heard at all.

8. Circuit

The Antenna Matching Preamplifier uses a 6AK5 miniature pentode tube. The extremely high transconductance of this tube allows good gain over a reasonably wide band of frequencies. The coils are loaded so that the pass-band will cover the entire amateur band. The gain drops only about two db at each end of the band when the coils are tuned for maximum gain at the center of the band.

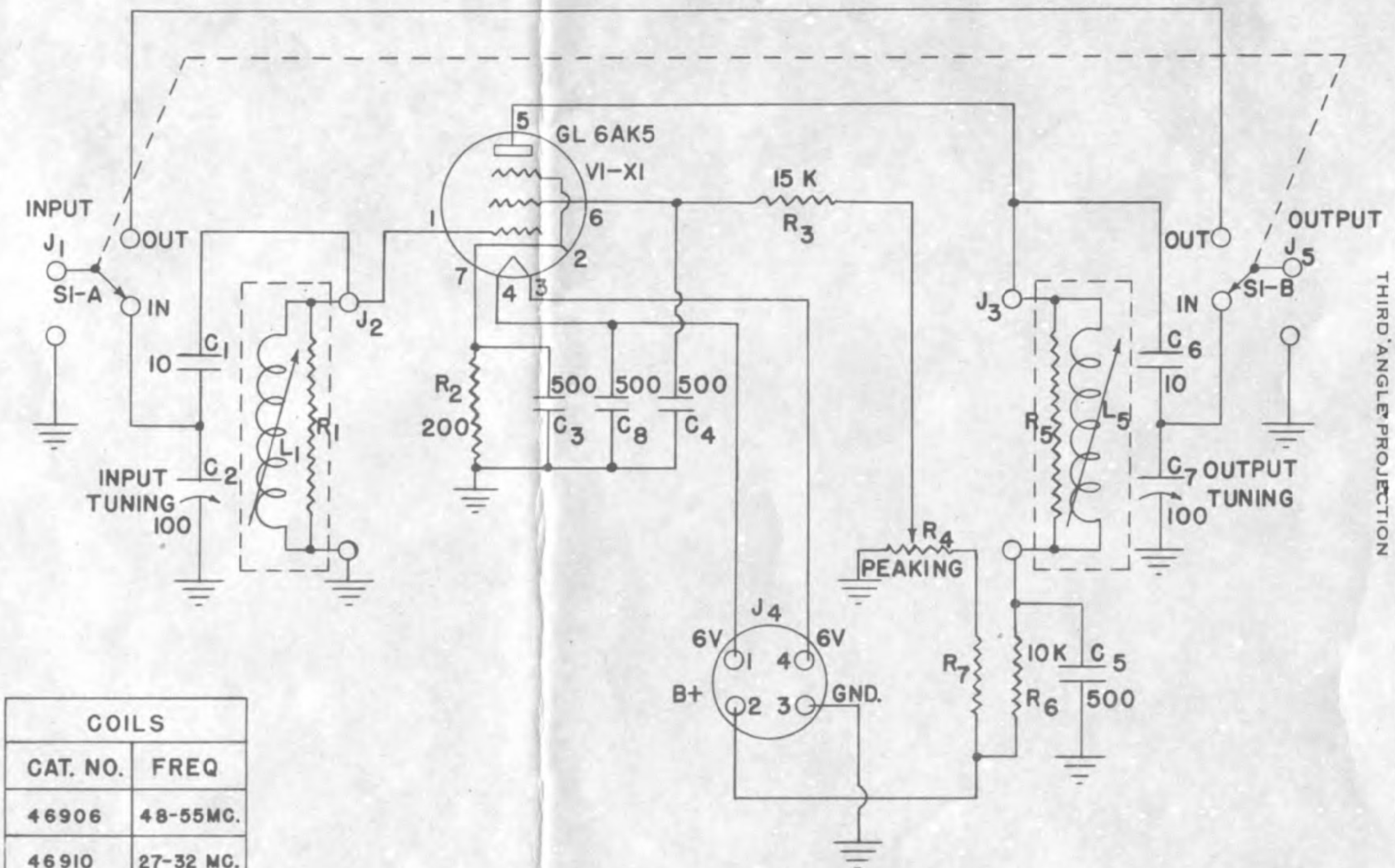
The INPUT TUNING condenser, C2, in series with C1, forms an impedance matching network. The two condensers in series also form the tuning capacity across the grid coil.

The OUTPUT TUNING condenser, C7, in series with C6, forms an impedance matching network in the output of the preamplifier. The two condensers in series also form the tuning capacity across the plate coil. The plate coil is grounded through the plate blocking condenser, C5, so that the OUTPUT TUNING condenser may be grounded.

Resistors R1 and R5 are loading resistors which are plugged in with the coil assembly. This makes it possible to use different loading and achieve different band-pass on each type coil assembly.

R. W. C. 2/3/47

THIRD ANGLE PROJECTION



K DENOTES 1000
RESISTORS IN OHMS
CAPACITORS IN MMFDS.

COILS	
CAT. NO.	FREQ
46906	48-55MC.
46910	27-32 MC.
46920	13-15 MC.

ALL DIMENSIONS UNLESS OTHERWISE NOTED MUST BE HELD TO A TOLERANCE OF

ANT. MATCHING PREAMPLIFIER

FIRST MADE FOR

DESIGNED BY

DRAWN BY

CHECKED BY

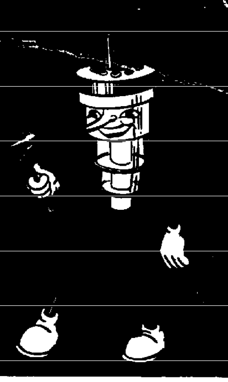
APPROVED

JAMES MILLEN MFG. CO., INC.
MALDEN, MASS., U.S.A.

K92101

DATE

HAM NEWS



THE R-9'ER

One-Tube Preamplifier Automatically Matches Antenna

ELECTRICAL CIRCUIT

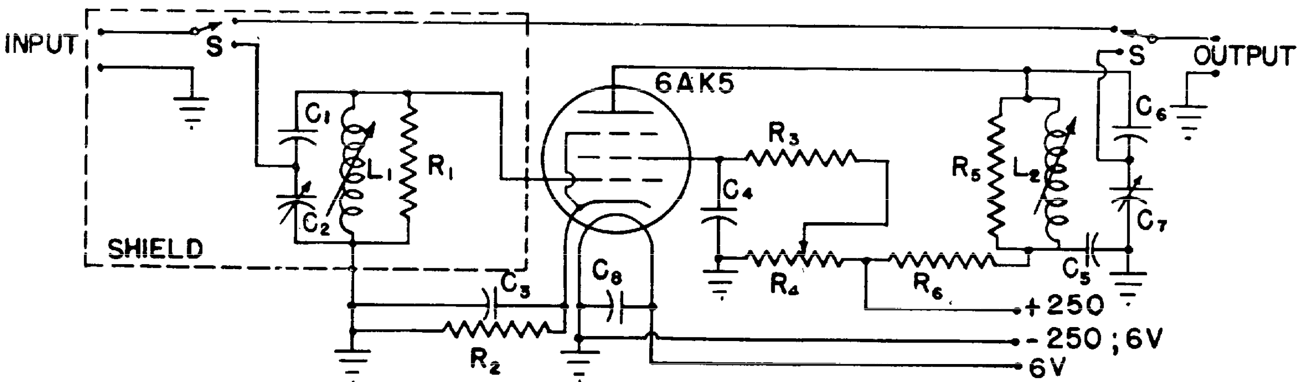


Fig. 1—Circuit Diagram of the R-9'er

CIRCUIT CONSTANTS

C_1, C_6	=5 mmf fixed ceramic
C_2, C_7	=100 mmf variable (Cardwell ZU-100-AS)
C_3, C_4, C_5, C_8	=500 mmf 400 volt mica
L_1, L_2	=Slug-tuned ceramic form (Millen No. 69041) 10 meters—16 turns No. 26 enam close wound 6 meters—8 turns No. 26 enam close wound
R_1, R_5	=7000 ohm, ½ watt
R_2	= 200 ohm, 1 watt
R_3	=15,000 ohm, ½ watt
R_4	=25,000 ohm, 4 watt potentiometer (Mallory M25MP)
R_6	=10,000 ohm, 1 watt
S	=DPDT wafer switch (Mallory 3222)

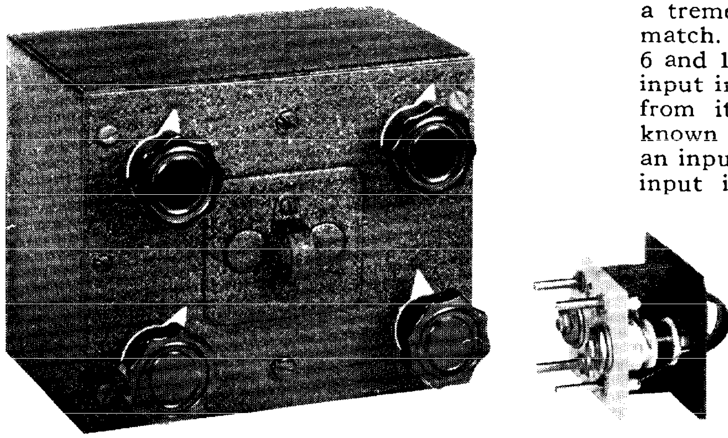


Fig. 2—Front View of R-9'er and Plug-in Coil

Are you having trouble picking those weak dx signals out of the noise? The R-9'er, using a single General Electric 6AK5 miniature tube, is designed to do exactly that. The R-9'er is an electronic impedance-matching device and a broad-band pre-amplifier, designed to work primarily on the 6 and 10 meter bands.

PERFORMANCE CHARACTERISTICS

The gain which can be achieved by this unit depends upon how well your antenna is matched to your receiver, but the minimum gain which may be expected is 30 decibels—about 5 R's! This gain comes about in two ways. The R-9'er, once it is tuned, automatically matches your receiving antenna to your receiver. In the usual ham shack this problem is not given much consideration, but a tremendous gain can be obtained by a proper match. The problem is doubly important on the 6 and 10 meter bands, as at these frequencies the input impedance of the receiver may vary widely from its stated value. For example, a widely known communication receiver, stated to have an input impedance of 250 ohms, actually had an input impedance of 1500 ohms on 10 meters. Tests made recently show that the average gain experienced, merely by properly matching the receiving antenna, is from several db to as high as 30 db.

In addition to this gain, the 6AK5 miniature tube acts as a broad-band r-f amplifier stage, giving an additional gain of approximately 30 db. This tremendous gain is possible only because of the electrical characteristics of the

6AK5. This tube has a transconductance of 5000 micromhos, which means that a voltage gain of approximately 35 can be achieved with a plate load of 7000 ohms, as used in the R-9'er. This amount of gain has been available only by former tubes at narrow band widths and with higher noise levels. The General Electric 6AK5 has been designed to give these high gains at wider band widths and at lower noise levels.

Here then is what the R-9'er will do for you—60 decibels gain (or more) if your present receiving antenna is not matched, or, assuming it is perfectly matched, a 30 decibel gain. In tests conducted at W2RDL's shack, the R-9'er brought in signals which could not ordinarily be heard even with the use of the BFO!

CIRCUIT DETAILS

Referring to Fig. 1, the circuit consists essentially of a broad-tuned grid and broad-tuned plate circuit, a standard cathode bias system, and an adjustable screen supply. The grid and plate circuits are identical except that capacitor C_5 is employed as a plate blocking capacitor so that the plate tuning capacitor may be grounded.

In the grid circuit, capacitors C_1 and C_2 form the impedance matching network. A regular two-wire transmission line from the receiving antenna is brought to the input terminals, or a single wire antenna may be used and connected to the input lead which connects to the junction of C_1 and C_2. Inductance L_1 must be tunable so that resonance may be achieved after C_2 has been adjusted to match the antenna. Once C_2 and L_1, as well as C_7, and L_2 have been set, no further tuning is required for operation on that particular band.

With the constants shown, the R-9'er will match any input and output between 16 ohms and 2700 ohms. This may be calculated:

$$\text{Impedance} = \frac{7000}{\left(\frac{C_1 + C_2}{C_1}\right)^2}$$

The same formula may be applied to the plate side by substituting C_6 for C_1 and C_7 for C_2.

All constants given must be strictly adhered to in duplicating the R-9'er, as even the values of the bypass capacitors are important. R_1 and R_2 must be 7000 ohms, as the band-width will be altered and the impedance formula changed if different values are used.

The band-width of the R-9'er with the constants as shown is approximately two megacycles on ten meters (28–30 mc) and five megacycles on six meters (50–55 mc), dropping off only one or two db at each end of the band when it is peaked in the center of that bandwidth.

The plate voltage is not critical, and any voltage available in your receiver will operate the 6AK5 satisfactorily.

CONSTRUCTIONAL DETAILS

The R-9'er is built in a 3 by 4 by 5 inch box, with all component parts mounted on the front panel. Figs. 3 and 4 show the essential details of construction. The switch, S, and the potentiometer, R_4, are the two controls on the upper part of the front panel, with capacitors C_2 and C_7 being mounted directly beneath.

The coil box occupies the central portion of the box, and is so arranged that the main support on

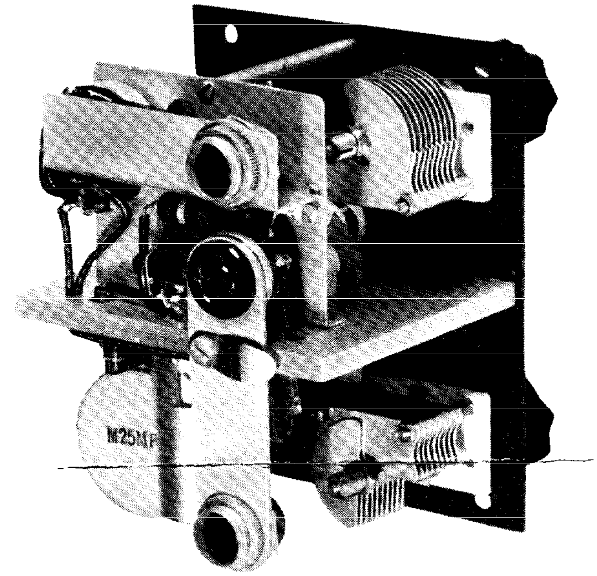


Fig. 3—Rear View of R-9'er Showing Constructional Features

the coil form, a piece of 7/8 inch by 1 1/2 inch aluminum, 1/4 inch thick, just fits into the central shield on the box, which is also made of 1/4 inch thick aluminum. With the coil plugged into the R-9'er, a solid shield is thus formed which completely isolates the grid section from the rest of the circuit. It is very important to have complete shielding between grid and plate. The polystyrene base on the coil is 1 3/4 inch by 1 1/2 inch, and the aluminum front of the coil measures 2 inches by 1 3/4 inches. One corner is cut on the polystyrene base in order to provide a method of keying the coils for proper insertion. The cutout in the panel is similarly keyed. The coil forms are mounted on a thin piece of aluminum (see Fig. 5 of page 4) so that the center of the grounding strip contacts a grounding spring mounted on the 1/4 inch aluminum shield. This grounding spring is identical to the one shown in Fig. 3 which is mounted on the rear of the shield. The purpose of the latter spring is to contact the inside of the box, in the rear, for good grounding.

The pins on the coil are Millen No. 10029, which fit into two crystal sockets (Millen No. 33002). These sockets are mounted on the 1/4-inch wide aluminum shield, as may be seen in Fig. 4.

(Continued on last page)

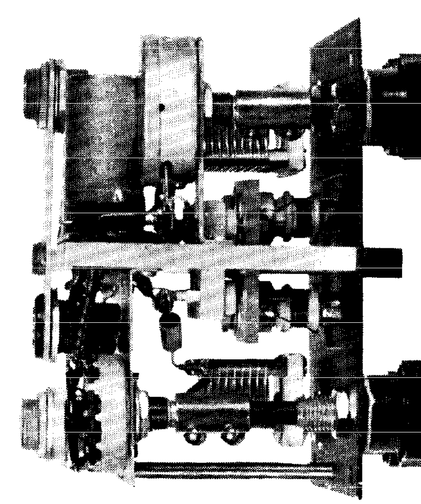


Fig. 4—Side View of R-9'er with Cover Removed

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QUESTIONS AND ANSWERS

Do you have any questions about tubes or tube circuits? Lighthouse Larry would like to answer them for you. For each question published you will receive $10 worth of G-E electronic tubes. All questions not published will be answered promptly by mail. Send your questions to Lighthouse Larry, Tube Division, Bldg. 269, General Electric Company, Schenectady, New York, or in Canada, to Canadian General Electric Company, Ltd., Toronto, Ont.

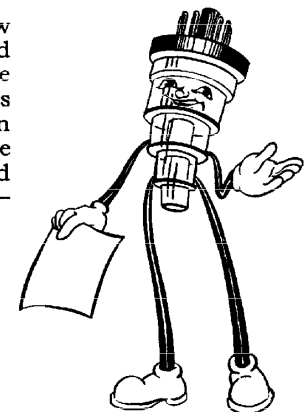
Question: Considering the case of a tube used as a Class C r-f amplifier, does the amplification factor (mu) of the tube bear any relationship to the driving power required?—W8UEN.

Answer: There is no simple relationship between the mu of a tube and the driving power required. Practical considerations in tube construction result in the fact that the optimum mu for triodes in Class C operation is about 20. In other words, a higher or lower mu tube might require more driving power than a tube with a mu of 20. A comparison of tube transconductance (Gm) is a better guide to driving power, as a tube with a high transconductance will require less drive than a tube with a low transconductance, if tubes with similar amplification factors are considered.—Lighthouse Larry.

Question: When using a neutralized triode with combination grid resistor and battery bias, is there an optimum ratio of battery voltage to resistance-developed voltage?—W2OCJ.

Answer: It is important to use sufficient fixed (battery or power-supply) bias to limit the plate current in the event that excitation fails. To use more fixed bias than this is not economical. In addition, use of grid-resistor bias has several advantages. The resistor acts as a current limiting device if a grid-to-cathode arc-over takes place. The grid resistor also prevents the grid of the tube from being driven to a high positive voltage.

The best rule to follow is to provide enough fixed bias to keep the plate dissipation within ratings in case of an excitation failure, and obtain the remainder of the required bias from a resistor.—Lighthouse Larry.



TRICKS AND TOPICS

How did you solve that last problem that almost had you stumped? Be it about tubes, antennas, circuits, etc., Lighthouse Larry would like to tell the rest of the hams about it. Send it in! For each "trick" accepted you win $10 worth of G-E Electronic Tubes. No entries returned. Submit to Lighthouse Larry, Tube Division, Bldg. 269, General Electric Company, Schenectady, New York or in Canada, to Canadian General Electric Company, Ltd., Toronto, Ont.

METAL CHASSIS PRESERVER

After building up a few very nice looking units on cadmium-plated chassis pans a few years ago, I was very disappointed to find that they had turned dark in color and had rusted in spots.

When the bands re-opened, I decided to rebuild, using new pans. I drilled and punched all the needed holes in the new cadmium pans, and used a ball of absorbent cotton soaked up in carbon tetrachloride to wipe the finished job all over, inside and out.

Then with a nice clean piece of cotton rag, I waxed the chassis inside and out, using regular paste auto wax. I then mounted the parts, even going so far as to soak up the little paper gaskets between the porcelain feed-through insulators with the wax.

After the parts were all mounted and the unit tested, I gave it another light going-over with the wax rag, without wiping off for the polishing effect.

My rig is in the basement, and these treated chassis pans look better now than the day I got them from the local distributor, in spite of the dampness that is attributed to basements.—W9GPI.

(Ed. Note: This trick really does the job, but care should be taken that the chassis is not handled after the final polishing, as the fingerprints may rub off enough wax to expose the chassis so that it will eventually rust.—L.L.)

RESONANT RECEIVER CHOKE

I ran across the following trick recently that helped me out of a bad situation. In the design of a high gain UHF superheterodyne receiver it was found necessary to use filament chokes to prevent regeneration. Inasmuch as the intermediate frequency was 12 megacycles, difficulties arose in trying to wind chokes to do the job at that frequency, because of the low distributed capacity of the choke and the high inductance required.

This problem was solved by making a resonant choke with a fixed capacitor in the following manner. A short piece of bakelite tubing was procured and a ceramic capacitor inserted in the tubing. The choke was then wound over the tubing, and connections made to the capacitor at each end of the coil, thus connecting the coil and capacitor in parallel.

For 12 megacycles the construction is: Tubing one inch long, $\frac{1}{4}$ inch O.D. and $\frac{3}{16}$ inch I.D. Capacitor, 20 mmf, Coil No. 30 enameled wire close-wound for $\frac{7}{8}$ inch.

In use, one choke is connected to each tube, right at the socket. The other filament lead is common.—Morris Allen.

The G-E 6AK5 tube is mounted horizontally. Fig. 3 and 4 show how the grid pin on the tube socket projects on one side of the shield with the remainder of the pins on the other side of the shield. Switch, S, is mounted on this shield. The input connection is mounted on a third shield which cuts through the center of switch, S, shielding the input and output circuits.

Placement of parts is not too critical if adequate shielding is maintained. Lack of shielding may cause unwanted regeneration and possible spurious oscillations.

OPERATING ADJUSTMENTS

Input and output connections should be made to the R-9'er with well-insulated wire, preferably coaxial cable. Switch S should be set so that the amplifier is cut out, and the receiver tuned to a signal in the approximate center of the band. A local signal is preferable. The amplifier should then be cut in by the switch, the screen potentiometer adjusted to give maximum voltage, and the grid condenser (C_2) tuned together with L_1 until the signal is heard. The signal should then be peaked with an R-meter or an output meter by tuning L_1, adjusting C_2, retuning L_1, readjusting C_2, etc., till the signal is maximum. This process should be repeated with the plate circuit, C_7 and L_2.

If C_1 is found to be at full maximum or minimum capacity, the length of the antenna feeder must be altered. Conversely, the length of the line between the R-9'er and the receiver must be altered if C_7 does not tune near its middle capacitance. To correct this situation, add a quarter-wave length of line and prune this line until the capacitor peaks the signal at approximately center scale. For 6-meter operation the output line should be as short as possible, to ensure minimum capacitance on the output side.

After the entire unit has been peaked, the screen potentiometer (R4) should be adjusted for maximum output, keeping the voltage on the 6AK5 screen as low as possible, with output as high as possible. Once all adjustments are made for both coils, it is only necessary to peak capacitors C_2 and C_7 when changing bands, as the coils remain at resonance after once being adjusted.

Coil data for L_1 and L_2 is given for only 6 and 10 meter operation, although the unit will operate on any band. However, most antennas match into the receiver reasonably well at 14 megacycles and lower frequencies, so that the R-9'er does not appear to give as much gain at the lower frequencies.

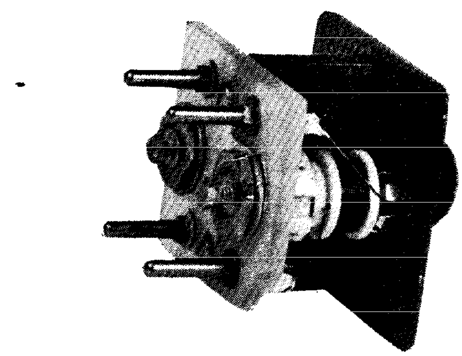
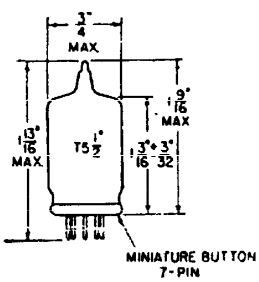
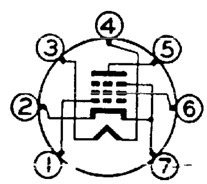


Fig. 5—View of R-9'er Coil Box (Note that Coil is Mounted on Polystyrene Base)

6AK5

BASING DIAGRAMS—PIN CONNECTIONS





Pin 1—Grid Number 1
Pin 2—Cathode and Grid Number 3
Pin 3—Heater
Pin 4—Heater
Pin 5—Plate
Pin 6—Grid Number 2
Pin 7—Grid Number 3

PARASITICS On page four of Ham News, Vol. I, No. 3, the tube basing diagram shown for the 50B5 should be used for the 12BA6 and vice versa.

CQ.... CQ.... Have you gotten the new G.E. Ham News Binder?

Your distributor has one for you— *73*

Lighthouse Larry

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.

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